CLAIMS

1. A method for analyzing a test sample, the method comprising:

performing a metrology operation at an analysis location on the test sample; and

directing a first cleaning beam at the analysis location during the metrology operation, the first cleaning beam being configured to remove contaminant material at the analysis location.

2. The method of Claim 1, wherein the surface of the test sample comprises a thin film.

3. The method of Claim 1, wherein the metrology operation comprises one of an ellipsometry analysis, a reflectometry analysis, an x-ray fluorescence analysis, an electron microprobe analysis, a contact-based electrical analysis, and a scanning electron microscope inspection/review.

4. The method of Claim 1, wherein performing the metrology operation comprises directing a measurement beam at the analysis location.

5. The method of Claim 4, further comprising adjusting the position of the test sample to simultaneously focus the first cleaning beam and the measurement beam on the analysis location.

6. The method of Claim 1, wherein the first cleaning beam comprises a pulsed cleaning beam.

7. The method of Claim 1, further comprising directing a second cleaning beam at a first portion of a contaminant layer

overlying the analysis location, wherein directing the second cleaning beam at the first portion of the contaminant layer is performed prior to performing the metrology operation at the first analysis location.

8. The method of Claim 7, wherein the first cleaning beam comprises a series of first cleaning pulses having a first period, each of the first cleaning pulses having a first width and a first intensity, and

wherein the second cleaning beam comprises a series of second cleaning pulses having a second period, each of the second cleaning pulses having a second width and a second intensity, wherein at least one of the second period, the second width, and the second intensity is different from the first period, the first width, and the first intensity, respectively.

9. The method of Claim 1, wherein the first cleaning beam comprises a series of first cleaning pulses, and wherein analyzing the test sample further comprises sampling an output beam generated from the analysis location in response to the measurement beam using a series of sampling pulses, each of the first cleaning pulses occurring between sampling pulses.

10. The method of Claim 9, wherein each of the first cleaning pulses occurs immediately after one of the sampling pulses.

11. The method of Claim 1, wherein the first cleaning beam comprises a series of first cleaning pulses, wherein analyzing the test sample further comprises sampling an output beam generated from the analysis location in response to the measurement beam at a sampling rate, and wherein the first

cleaning beam comprises a cleaning pulse rate, the cleaning pulse rate being equal to a submultiple of the sampling rate.

12. The method of Claim 1, wherein the first cleaning beam comprises a series of first cleaning pulses,

wherein analyzing the test sample further comprises sampling an output beam generated from the analysis location in response to the measurement beam using a series of sampling pulses at a sampling rate, and

wherein directing the measurement beam at the analysis location comprises:

modulating the measurement beam into a series of measurement pulses having a measurement pulse rate, the measurement pulse rate being equal to the sampling rate; and

blocking the measurement beam during each of the first cleaning pulses.

13. The method of Claim 12, wherein each of the first cleaning pulses heats the analysis location above a baseline temperature, the analysis location returning to the baseline temperature after a cooldown period after each first cleaning pulse, wherein directing the measurement beam at the first analysis location further comprises blocking the measurement beam during the cooldown period after each first cleaning pulse.

14. The method of Claim 13, wherein directing the measurement beam at the analysis location further comprises blocking the measurement beam between sampling pulses.

15. The method of Claim 1, wherein the first cleaning beam comprises a series of first cleaning pulses, and wherein analyzing the test sample further comprises:

gathering data samples of beam characteristics for an output beam generated from the analysis location in response to the measurement beam; and

clamping the data samples at a first level during each of the first cleaning pulses, the first level comprising the beam characteristics for the output beam just prior to each of the first cleaning pulses.

16. The method of Claim 15, wherein each of the first cleaning pulses disturbs the analysis location from a baseline condition, the analysis location returning to the baseline condition after a recovery period after each first cleaning pulse, wherein analyzing the test sample further comprises clamping the data samples at the first level during the recovery period after each first cleaning pulse.

17. The method of Claim 1, wherein the first cleaning beam comprises a series of first cleaning pulses, and wherein analyzing the test sample further comprises:

gathering data samples from an output beam generated from the analysis location in response to the measurement beam; and

deleting data samples taken during each of the first cleaning pulses.

18. The method of Claim 17, wherein each of the first cleaning pulses disturbs the analysis location from a baseline condition, the analysis location returning to the baseline condition after a recovery period after each first cleaning pulse, wherein analyzing the test sample further comprises deleting data samples taken during the recovery period after each first cleaning pulse.

19. The method of Claim 1, wherein the first cleaning beam comprises a series of first cleaning pulses, and wherein analyzing the test sample further comprises:

gathering data samples from an output beam generated from the analysis location in response to the measurement beam; and

replacing data samples taken during each first cleaning pulse with a first data sample taken just before the each first cleaning pulse.

20. The method of Claim 19, wherein each of the first cleaning pulses disturbs the analysis location from a baseline condition, the analysis location returning to the baseline condition after a recovery period after each first cleaning pulse, wherein analyzing the test sample further comprises replacing data samples taken during the recovery period after each first cleaning pulse with the first data sample.

21. A metrology system for analyzing a test sample, the metrology system comprising:

an analysis subsystem for performing an analysis operation at an analysis location on a first surface of the test sample to analyze the test sample; and

a cleaning subsystem for directing a cleaning beam at the analysis location during the analysis operation to remove contaminant material from the analysis location.

22. The metrology system of Claim 21, wherein the cleaning beam comprises a pulsed beam.

23. The metrology system of Claim 22, wherein the cleaning subsystem comprises a Q-switched laser for generating the pulsed beam.

24. The metrology system of Claim 21, wherein the analysis subsystem comprises a measurement emitter for directing a measurement beam at the analysis location, the metrology system further comprising a focusing subsystem for positioning the analysis subsystem and the cleaning subsystem so that the measurement beam and the pulsed cleaning beam are simultaneously focused on the analysis location.

25. The metrology system of Claim 24, wherein the focusing subsystem directs a focusing beam at the test sample to determine a position of the test sample, the focusing beam having a first directional component parallel to the first surface, the measurement beam having a second directional component parallel to the first surface, the first directional component being nonparallel with the second directional component.

26. The metrology system of Claim 24, wherein the focusing subsystem comprises:

a focusing emitter for directing an alignment beam at the test sample to generate a reflected beam; and

a focusing receiver for measuring positional characteristics of the reflected beam.

27. The metrology system of Claim 26, wherein the focusing emitter comprises a white-light lamp for generating the alignment beam, a first near-infrared (NIR) filter positioned in-line with the alignment beam from the white-light lamp, a first set of directional optics for directing the alignment beam through a

first set of focusing optics, the first set of focusing optics focusing the alignment beam onto the test sample, and

wherein the focusing receiver comprises a second set of directional optics for focusing the reflected beam onto a position-sensitive detector through a second NIR filter via a second set of directional optics.

28. The metrology system of Claim 26, wherein the cleaning subsystem comprises a cleaning beam source for generating the pulsed cleaning beam, first set of directional optics for directing the pulsed cleaning beam at a dichroic mirror, the dichroic mirror being configured to reflect the pulsed cleaning beam through a first set of focusing optics onto the analysis location,

wherein the focusing emitter comprises a white-light lamp for generating the alignment beam, a first NIR filter positioned in-line with the alignment beam from the white-light lamp, a second set of directional optics for directing the alignment beam through a second set of focusing optics, the second set of focusing optics focusing the alignment beam onto the test sample, and

wherein the focusing receiver comprises a position-sensitive detector, a third set of directional optics, and a second NIR filter, the first set of focusing optics focusing the reflected beam through the dichroic mirror and into the third set of directional optics, the third set of directional optics directing the reflected beam through the second NIR filter onto the position-sensitive detector.

29. The metrology system of Claim 21, wherein the analysis subsystem comprises one of a single-wavelength ellipsometer (SWE), a spectroscopic ellipsometer (SE), a reflectometer, a non-

contact electrical measurement system, a grazing x-ray reflectometry system (GXR), an x-ray fluorescence (XRF) system, an electron microprobe analysis (EMP) system, a contact-based electrical measurement system, and a scanning electron microscope inspection/review system.

30. The metrology system of Claim 21, wherein the analysis subsystem comprises:

a measurement emitter for generating the measurement beam; and

a measurement receiver for taking measurement samples of beam characteristics for an output beam generated from the analysis location in response to the measurement beam.

31. The metrology system of Claim 30, wherein the measurement emitter comprises an acousto-optical modulator for modulating the measurement beam.

32. The metrology system of Claim 30, wherein the cleaning beam comprises a series of cleaning pulses, and wherein the measurement receiver comprises a clamp circuit for clamping the measurement samples taken during each cleaning pulse at a first level, the first level comprising beam characteristics from a reference measurement sample taken just before the each cleaning pulse.

33. The metrology system of Claim 32, wherein each cleaning pulse disturbs the analysis location from a baseline condition for a first duration after the each cleaning pulse, the clamp circuit further clamping the measurement samples taken during the first duration after each cleaning pulse at the first level.

34. The metrology system of Claim 32, wherein the measurement receiver further comprises:

a detector for generating data signals in response to the output beam;

an amplifier circuit for amplifying the data signals into raw measurement data;

a sample/hold circuit configured to pass the raw measurement data as processed data;

a low-pass filter coupled to filter high frequency noise from the processed data to generate filtered data;

an analog-to-digital (A/D) converter for sampling the filtered data to generate a set of output data; and

a control circuit for providing a clamp signal to the sample/hold circuit, the clamp signal causing the sample/hold circuit to maintain the level of the processed data constant until the clamp signal is deasserted, the control circuit asserting the clamp signal during each cleaning pulse.

35. The metrology system of Claim 34, wherein each cleaning pulse disturbs the analysis location from a baseline condition for a first duration after the each cleaning pulse, the control circuit further asserting the clamp signal during the first duration after each cleaning pulse.

36. The metrology system of Claim 21, wherein the analysis subsystem is configured to collect data samples of beam characteristics for an output beam generated from the analysis location in response to the measurement beam, and wherein the cleaning beam comprises a series of cleaning pulses, the metrology system further comprising a computer for discarding data samples taken during each cleaning pulse.

37. The metrology system of Claim 36, wherein each cleaning pulse disturbs the analysis location from a baseline condition for a first duration after the each cleaning pulse, the computer *further discarding data samples taken during the first duration* after each cleaning pulse.

38. The metrology system of Claim 21, wherein the analysis subsystem is configured to collect data samples of beam characteristics for an output beam generated from the analysis location in response to the measurement beam, and wherein the cleaning beam comprises a series of cleaning pulses, the metrology system further comprising a computer for replacing data samples taken during each cleaning pulse with a data sample taken just before the each cleaning pulse.

39. The metrology system of Claim 38, wherein each cleaning pulse heats the analysis location above a baseline temperature for a first duration after the each cleaning pulse, the computer further replacing data samples taken during the first duration after each cleaning pulse with the data sample taken just before the each cleaning pulse.

40. A metrology system for analyzing a test sample, the metrology system comprising:

means for performing a metrology operation at a analysis location on a first surface of the test sample; and

means for cleaning the analysis location comprising means for directing a cleaning beam at the analysis location during the metrology operation to remove contaminant material from the analysis location.

41. The metrology system of Claim 40, wherein the cleaning beam comprises a pulsed beam.

42. The metrology system of Claim 41, wherein the means for cleaning comprises a Q-switched laser for generating the pulsed beam.

43. The metrology system of Claim 40, wherein the means for performing the metrology operation comprises a measurement emitter for directing a measurement beam at the analysis location, the metrology system further comprising means for positioning the analysis subsystem and the cleaning subsystem so that the measurement beam and the cleaning beam are simultaneously focused on the analysis location.

44. The metrology system of Claim 40, wherein the metrology operation comprises one of an ellipsometry analysis, a reflectometry analysis, an x-ray fluorescence analysis, an electron microprobe analysis, a contact-based electrical analysis, and a scanning electron microscope inspection/review.

45. The metrology system of Claim 40, wherein the means for performing the metrology operation comprises:

means for directing a measurement beam at the analysis location; and

means for modulating the measurement beam.

46. The metrology system of Claim 40, wherein the cleaning beam comprises a series of cleaning pulses, and wherein the means for analyzing comprises:

means for directing a measurement beam at the analysis location;

means for taking measurement samples of beam characteristics for an output beam generated from the analysis location in response to the measurement beam; and

means for maintaining the measurement samples taken during each cleaning pulse at a first level, the first level comprising beam characteristics from a reference measurement sample taken just before the each cleaning pulse.

47. The metrology system of Claim 46, wherein each cleaning pulse disturbs the analysis location from a baseline condition for a first duration after the each cleaning pulse, the means for maintaining the measurement samples further maintaining the measurement samples taken during the first duration after each cleaning pulse at the first level.